The Effect of Innovation, Logistic Performance, and Human Capital on Export Diversification of Manufacturing Industry

Melia Madonna[1*] and Rossanto Dwi Handoyo[2]

[1,2]Master of Economics Study Program, Faculty of Economics and Business, Universitas Airlangga

melia.madonna78@gmail.com

Abstract

This study aimed to analyze the effect of innovation, logistics performance, and human capital on export diversification of the manufacturing industry based on technology intensity in Indonesia. This study uses the method of moments approach with estimation using the Generalized Method of Moments (GMM). The research was conducted using dynamic data panels belonging to Indonesia and 30 main export destination countries as research objects. The results show the average Global Innovation Index (GII) of Indonesia and export countries, the average Logistics Performance Index (LPI) of Indonesia and export destination countries, the labor force with intermediate education, labor force with basic education. Indonesia's GDP has a positive and significant effect on the diversification of manufacturing industry commodity exports in Indonesia across all technological intensities. Still, the importers' GDP and exchange rates positively influence the spread of diversification exports of manufactured industrial commodities in Indonesia, but some models show no significant relationship.

Keywords: export diversification, innovation, logistics performance, human capital

JEL : O11, O14, O15

DOI : 10.24002/kinerja.v27i1.6459

Received : 10/04/2022 Reviewed: 11/23/2022 Final Version: 03/12/2023

1. INTRODUCTION

Increasingly competitive market conditions have compelled various countries around the world to develop their export strategies. One strategy that can be applied to increase competitiveness in global trade is to diversify exports (Cirera et al., 2015). Export diversification can be interpreted as a policy of a country held to expand export destination countries or economic sectors involved in export activities and change products from primary goods to processed goods. Lian et al. (2021) define export diversification as a summary containing how varied the products in a country's export basket are. A country's exports can be said to be diversified if they have a variety of products or have many export destination countries. According to Agosin et al. (2014), the higher the level of export diversification of a country, the more positive the economic growth of that country will be. Countries whose exports are diversified will have many advantages. The higher the level of export diversification, the less risk the exporter country has because the exporter country will have more choices of substitutes both horizontally and vertically, so export activities will become more stable.

Export diversification can be divided into two types, namely horizontal export diversification and vertical export diversification. Horizontal export diversification refers to export diversification that uses destination countries to allow exporter countries to enter new export destination markets. Meanwhile, vertical export diversification is diversification carried out through increasing product varieties so that exports will have a much wider spectrum of goods. Therefore, when an exporter country experiences pressure on the export performance of a commodity, that country can rely on exports of other commodities. Likewise, with export destination countries, when a country decides to stop being an importer, the exporter country can rely on other importing countries. Therefore, the more diversified a country's exports are, the more that country's exports can be said to follow the tastes of market demand and are able to capture market share.

Innovation and creativity are components that make an important contribution to the diversification of the manufacturing industry's commodity exports. Innovation in the production process will increase the added value of finished goods produced, which will then contribute to GDP (Espoir, 2020). Innovations in export diversification also provide additional convenience for new export products to enter the global market. In recent years, many exporters from developing countries have been involved in the introduction of new products for export activities (Cirera et al., 2015). The contribution of exporters from developing countries to the introduction of new export products has reached 25% in a few years. Most of the new export products introduced to the global market are industrial products, both high-tech and low-technology industries. The development of innovation capacity is the main factor that encourages industries to engage in export diversification activities. Innovation can directly play a role in becoming an industry's competitive advantage in a sustainable international market (Oura et al., 2016). The competitive advantage generated by innovation gives the industry distinguishing characteristics that other industries cannot imitate due to differences in the resources used. In addition, industries with high innovation capacity will have a greater opportunity to expand their export activities in international markets.

Logistics performance has an important role in increasing export growth. Logistics performance in international trade is not only related to the transportation used in the delivery of exported goods but also related to the construction and availability of infrastructure facilities and outbound supply regulation policies. Therefore, a country needs to evaluate and understand its logistics performance in order to set policy targets related to better transportation in facilitating trade between countries (Kabak et al., 2018). In export activities, logistics is not only related to transportation used to transport goods and services produced. Logistics is also related to regulating the amount of supply by managing the flow of inputs in the production process to accelerate the process of producing goods and services for export growth. Finished goods that have been produced will then be distributed to importers. The quite large number of roles taken by the logistics sector in the production process of goods and services for export causes the performance of the logistics sector to be considered as one of the important factors in export activities.

Human capital as a whole influences export diversification either directly or indirectly. Education is one of the dimensions of the human capital variable that has the greatest influence on export performance (Mubarik et al., 2020). The educational level of human capital can be measured by years of schooling, the last education taken, and whether human capital continues education to a higher level. Human capital can not only be measured by the level of education but can also be measured by the Human Development Index (HDI) of a country. Human capital in each country has different characteristics due to differences in spatial factors. Differences in individual and spatial characteristics can be seen based on education, age, quality of life in certain areas, and attributes of the local labor market.

The export of manufactured industrial commodities is one of the sectors that contribute significantly to Indonesia's Gross Domestic Product (GDP) (Indonesia's Ministry of Industry, 2018). According to Gnangnon (2020), for a long time, many studies have neglected other economic sectors because they consider the manufacturing industry a more important aspect, considering its role in the global market. In the last ten years (2011-2020), the total volume of Indonesia's exports has had a number that tends to fluctuate (World Trade Organization, 2021). The contribution of industrial commodity exports to Indonesia's total export volume has a value of more than 50%. Exports of industrial commodities also have more diverse export destination countries. Figure 1 shows that the exports of 15 leading manufacturing industry commodities used in this study contributed 41% of the total volume of Indonesia's exports. The above statement makes the manufacturing industry's commodities attractive to be used as research variables.

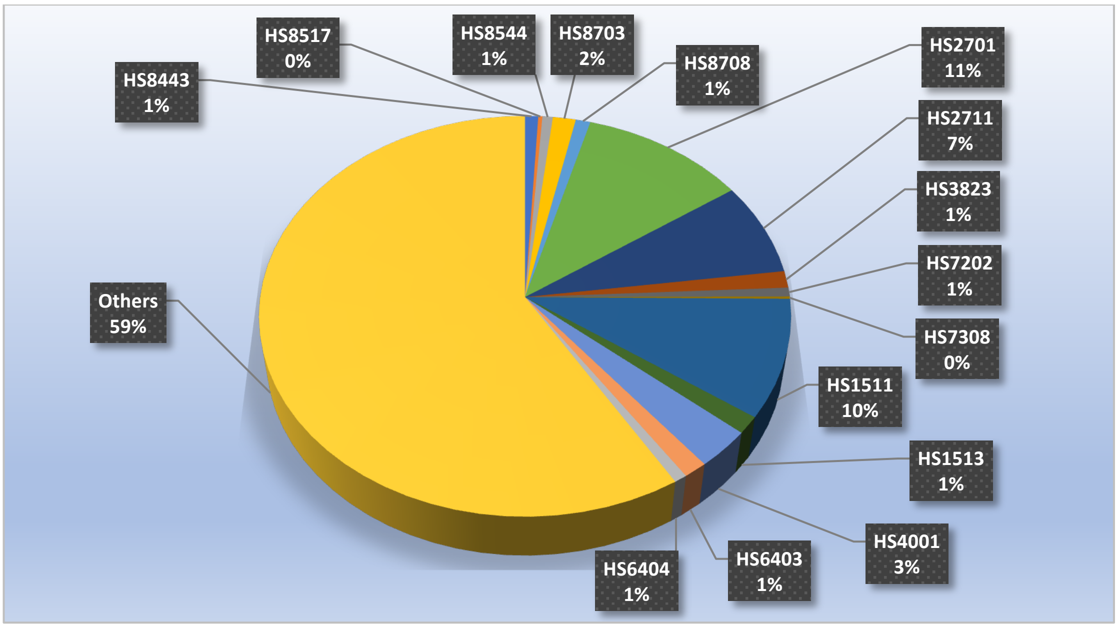

Figure 1. Export Contribution of 15 Leading Manufacturing Industry Commodities 2011-2020 to Total Export Volume in Indonesia

Source: World Trade Organization (2020)

The structure of the manufacturing industry can be classified based on the intensity of the technology applied in the production process (Ying et al., 2014). Based on this statement, the manufacturing industry can be grouped into three groups: High Technology Manufacturing, Medium Technology Manufacturing, and Low Technology Manufacturing. Based on the intensity of the technology used in the production process, the manufacturing industry, with the application of high-level technology, will produce finished goods with a greater gross added value than the manufacturing industry with medium and simple technology intensity (Aneja & Arjun, 2021). This reason makes many developing countries compete to increase the intensity of technology applied in the production process in an effort to increase the added value of industrial commodities, which will then be exported.

This paper can make a scientific contribution because the number of studies related to export diversification as an indicator that represents export performance as the dependent variable is still very limited. Research that classifies manufacturing industry commodities based on technology intensity is also limited. Many studies used the value of R&D expenditure to represent innovation. Still, we use the value of the Global Innovation Index (GII) to represent innovation because GII can explain innovation better and more relatable. This paper also uses the latest time frame for the data from 2016 to 2020.

2. LITERATURE REVIEW

The concept of competitive advantage was first introduced by Michael E. Porter in 1985. This concept has a direction towards capabilities obtained from mechanisms and resources. The capabilities acquired are efforts to achieve competitiveness at a higher level compared to other competitors in the same industry or market. The concept of competitive advantage provides advice to exporting countries to carry out additional processes in export activities. The additional process in question is in the form of primary product processing as well as raw materials, which so far have trapped many exporting countries into a low economic condition caused by the terms of trade. Processing of primary products or raw materials in question is in the form of the establishment of a manufacturing industry. This problem is attempted to be overcome by the concept of competitive advantage by emphasizing the maximization of economies of scale in production activities. The aim is to produce goods and services at a higher price. Competitive advantage can be divided into two categories: external competitive advantage and internal competitive advantage. External competitive advantage uses three aspects of assessment, namely how exporters use new services to increase competitiveness; how exporters enter new markets; and better service quality compared to other competitors, including logistics services (Chiu & Yang, 2019). There are two ways to achieve competitive advantage over other competitors: cost advantage and differentiation advantage. A cost advantage is a condition when an exporter provides the same products and services as its competitors, albeit at a lower cost. Differentiation advantage is a condition when an exporter provides better and more diverse products and services than its competitors.

According to Chiu and Yang (2019), competitive advantage can be divided into two based on the assessment aspect. The first is an internal competitive advantage which takes into account three aspects, namely 1) increased innovation, 2) domain knowledge, and 3) job satisfaction. Next is an external competitive advantage which emphasizes an assessment based on three aspects in the form of 1) exporters' efforts to use new services as an effort to increase competitiveness, 2) how exporters enter new markets, and 3) better service quality compared to other competitors. Competitive advantage can be obtained in two ways, namely through cost advantage and differentiation advantage. Exporters do cost advantage by providing products and services at lower costs compared to other competitors even though the products and services are the same as competitors. Exporters carry out the advantage of differentiation by providing products and services that are more diverse and different compared to competitors in the market.

Innovations that affect export diversification will help exporters achieve a competitive advantage. Exporters will be able to increase innovation and increase domain knowledge through investment in R&D. Innovation will help exporters to be able to enter new markets through the discovery of new products that arise from innovation as a result of R&D. Discovery of new products as an innovation resulting from R&D developments will also help exporters to be able to achieve differentiation advantages because the new products found will increase the spectrum of goods in the export basket (Vergara, 2021; Lian et al., 2021; & Cirera et al., 2015).

Eli Heckscher and Bertil Ohlin at the Stockholm School of Economics first developed the Heckscher-Ohlin (H-O) model. This model is based on David Ricardo's theory of comparative advantage by predicting trade and production patterns based on the endowments of a trade area. The theory of comparative advantage has several weaknesses that must be refined so that economists Eli Hecksher and Bertil Ohlin in the Hecksher-Ohlin theory develop the theory of David Ricardo. The model says that a country exports products using abundant factors of production and imports products using factors that are relatively scarce in that country (Appleyard & Field, 2014).

The H-O theory discusses the basis of comparative advantage, namely technology, and production, which are influenced by endowment factors (owners of production factors) and intensity (technology used in production. In theory, H-O has two curves, namely isocost, and isoquant. So that when the two curves intersect at the optimum point, at a certain cost, the maximum product will be obtained, or at the minimum cost, it will produce a certain product. Endowment factors in the production process (land, labor, and capital) determine a country's comparative advantage. Countries have a comparative advantage over goods that have relatively abundant factors of production locally. This happens because the cost of inputs determines the profitability of goods. Goods with abundant inputs tend to be cheaper to produce than those with scarce inputs. For example, countries where capital and land are abundant, but labor scarce tend to have a comparative advantage in goods that require a lot of capital and land but little labor. Conversely, goods that are labor intensive are very expensive to produce because labor is scarce, and the price is high. Therefore, the country is better off importing these goods.

Figure 2 is a model form of the H-O theory which describes the United States as a capital-intensive country and China as a labor-intensive country. The curve below assumes that the United States is capital-intensive in aircraft production and China is labor-intensive in textile production. The United States has a greater capability of producing aircraft than China. So, the American production possibilities curve is skewed towards airplanes and China, which has a greater capacity for textile production, making the production possibilities curve more skewed (biased) towards textiles.

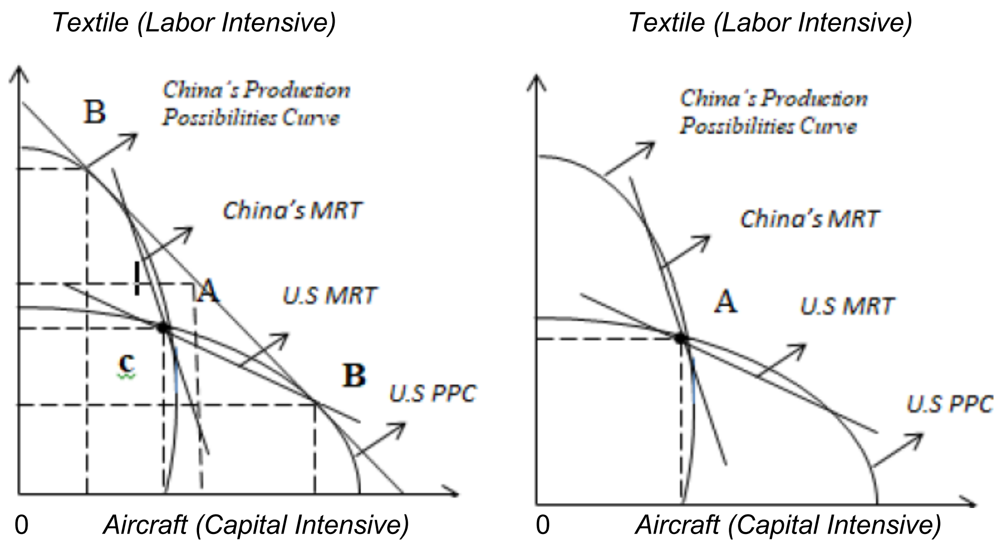

Figure 2. H-O Curves
Source: Salvatore (2012)

3. METHODOLOGY

This study uses a panel data type regression method which is intended to be able to determine the effect given by innovation, logistics performance, and human capital on the diversification of exports of manufacturing industrial commodities in Indonesia based on technology intensity from 2011 to 2020. The empirical model will be analyzed using the Generalized Method of Moments (GMM) using STATA 13 software.

The research will use six models. Each model used will explain the influence of the relationship between variables specifically. The variation of the model used in the study is based on the hypothesis that the higher the intensity of the technology used in the manufacturing industry, the higher the quality of human resources will be required. In this study, the education dimension is used as a benchmark to assess the quality of human resources. The model that will be used in this study will be explained as follows:

1. A model that uses the Labor Force with Intermediate Education variable as a human capital proxy for each commodity in the manufacturing industry with high, medium, or low technology intensity. This model will explain how the influence of innovation, logistics performance, and human capital on the diversification of manufacturing industry commodity exports at each technology intensity with a workforce with secondary education, which is considered the level of advanced education. The model will be written as follows:

$$DE_{ijt} = DE_{ijt-1} + \beta_1 AGII_{it} + \beta_2 ALPI_{it} + \beta_3 LFIE_{it} + \beta_4 lnGDPDom_{it} + \beta_5 lnGDPFor_{jt} + \beta_6 lnER_{it} + \varepsilon_{it} \quad (3.1)$$

2. A model in which the Labor Force with Basic Education variable is used as a proxy for human capital for each commodity manufacturing industry with a high, medium, or low technology intensity. This model will explain how the influence of innovation, logistics performance, and human capital on the diversification of manufacturing industry commodity exports at each technology intensity, with the basic education level considered the lowest level of education. The model will be written as follows:

$$DE_{ijt} = DE_{ijt-1} + \beta_1 AGII_{it} + \beta_2 ALPI_{it} + \beta_3 LFBE_{it} + \beta_4 lnGDPDom_{it} + \beta_5 lnGDPFor_{jt} + \beta_6 lnER_{it} + \varepsilon_{it} \quad (3.2)$$

DE_{ijt} is the diversification of Indonesian exports to destination countries. DE_{ijt-1} is the lag of Indonesia's export diversification to destination countries. $AGII_{it}$ is the average Global Innovation Index of Indonesia and export destination countries. $ALPI_{it}$ is the average Logistics Performance Index of Indonesia and export destination countries. $LFIE_{it}$ is the labor force with intermediate education in Indonesia. $LFBE_{it}$ is labor force with basic education in Indonesia. $lnGDPDom_{it}$ is the natural logarithm of Indonesia's Gross Domestic Product. $lnGDPFor_{jt}$ is natural logarithm of Gross Domestic Product Foreign (export destination countries). $lnER_{it}$ is the exchange rate's natural logarithm.

Table 1. Variables and Source of Data

Variable	Denomination	Measurement	Sources
Export Diversification	Value (0-1)	$HHI = \sum_{i=1}^{n} \left(\frac{S_i}{S}\right)^2$	The data is processed based on global export data published by the World Trade Organization (WTO) on the Trade map website (2021)
Global Innovation Index	Value (0-100)		World Intellectual Property Organization (WIPO) (2021)
Logistics Performance Index	Value (0-5)		World Bank (2021)
Labor Force with Intermediate Education	Percent (%)		World Bank (2021)
Labor Force with Basic Education	Percent (%)		World Bank (2021)
GDP	US Dollar		World Bank (2021)
Exchange Rate	Currency/Rupiah	$ER = \frac{USD/Rp}{USD/x}$	Bank Indonesia (2021) dan World Bank (2021)

Source: Author (2022)

This study uses the Generalized Method of Moments (GMM). The use of the GMM method can produce consistent and unbiased estimates. Some endogeneity problems contained in the dynamic panel model, such as those in the parameter μ where yit is a function of μi so that the lag of the independent variable or yit-1 also acts as a function of μi can be overcome by using the GMM method. The GMM method uses two autoregressive linear model estimates, namely First-differences GMM (FD-GMM) and System GMM (SYS-GMM). This study uses the System GMM

(SYS-GMM) method with the assumption that the System GMM (SYS-GMM) model is better than the First-differences GMM (FD-GMM) model. According to Lubis (2013) the System GMM (SYS-GMM) is more efficient than the First-differences GMM (FD-GMM) due to the use of additional level information in the form of conditional moments and instrument variable matrices by combining them.

3.1. Estimation of GMM

The GMM method can be defined as a parameter estimation method that only depends on the current conditions used. GMM is one method with advantages that can overcome the violation of assumptions such as autocorrelation and heteroscedasticity in the data. The first advantage of GMM is that it will be statistically more robust if the parameter estimates have the same value. The second advantage is that the GMM method can provide consistent and efficient estimates of the presence of heteroscedasticity (Ullah et al., 2018). According to Arellano and Bond (1991) in Čížek (2016), the estimation of GMM starts from a theoretical relationship that parameters must meet.

3.2. Model Spesification Test

Hansen's test was conducted to know the validity of instrument variables whose number exceeds the number of estimated parameters, which is called the condition of overidentifying restrictions.The Arellano-Bond test was conducted to determine the consistency of the estimation results, which can be known by the presence or absence of autocorrelation in it.

3.3. Robustness Test

The robustness test is a way to test a research model, whether the research model used is solid or not if there are differences or changes in variables in the research model. The robustness test can be done by adding or removing one of the variables contained in the research model. The endurance test can also be done by looking at the consistency of the model coefficient values, which are estimated using different methods. This study uses the Pooled Ordinary Least Square (PLS) and Fixed Effects (FE) methods to see the robustness of the model used in this study. This technique is carried out after estimating using the GMM method. The model used in this study will be estimated using the PLS and FE methods to see the value of the coefficients of each variable. If the value is consistent, the model can be said to be robust.

4. RESULT AND DISCUSSION

The statistical description of variables classified based on the intensity of the technology used in the production process:

Table 2. Variable Statistics Description

Variable	Obs	Mean	Std. Dev	Min	Max
DE (high technology)	300	0.0132222	0.0187474	1.84e-06	0.2010105

DE (medium technology)	300	0.0154082	0.0325637	2.44e-06	0.4025427
DE (low technology)	300	0.0108555	0.0067313	0.0007554	0.0590691
AGII	300	36.92537	6.412545	22.115	49.27
ALPI	240	3.255957	0.2590508	2.655	3.675
LFIE	300	71.317	0.5003365	70.7	72.18
LFBE	300	62.535	0.8021658	61.23	63.52
GDPDom	300	9.64e+11	8.30e+10	8.61e+11	1.12e+12
GDPFor	300	2.18e+12	3.79e+12	6.03e+10	2.14e+13
ER	300	6225.172	6312.104	0.4194143	20367.87

Source: Data Processed by Author (2022)

The data estimated using the GMM method show the following results:

Table 3. Estimation Results Using the GMM Method

Variable	*High Tech*		*Med Tech*		*Low Tech*	
	Model 1	**Model 2**	**Model 3**	**Model 4**	**Model 5**	**Model 6**
DE	0.000***	0.000***	0.000***	0.000***	0.000***	0.000***
L1.	0.5785479	0.4507271	0.5333674	0.5315085	0.2324587	0.1240982
AGII	0.007***	0.000***	0.007***	0.004***	0.002***	0.003***
	0.0005424	0.0006579	0.0004722	0.0005158	0.0001742	0.0001705
ALPI	0.011**	0.000***	0.001***	0.003***	0.007***	0.008***
	0.0183537	0.0208926	0.0062834	0.0070204	0.0038263	0.0041944
LFIE	0.000***	-	0.018**	-	0.008***	-
	0.0047246		0.0018951		0.0001956	
LFBE	-	0.000***	-	0.014**	-	0.028**
		0.002477		0.0005224		0.0004807
lnGDPDom	0.000***	0.000***	0.058*	0.087*	0.015**	0.004***
	0.0480863	0.0520961	0.0056027	0.0019024	0.0101098	0.0124984
lnGDPFor	0.338	0.467	0.547	0.527	0.001***	0.002***
	0.00065	0.0004848	0.0003988	0.0004341	0.0005832	0.0005362
lnER	0.000***	0.000***	0.076*	0.071*	0.109	0.021**
	0.0017932	0.0016983	0.0008549	0.0008499	0.0001651	0.0002391
AR(1)	0.425	0.683	0.297	0.297	0.023	0.039
AR(2)	0.659	0.820	0.659	0.762	0.234	0.249
Sargan Test	0.000	0.080	0.000	0.000	0.000	0.000
Hansen Test	0.116	0.368	0.570	0.667	0.820	0.916
Prob > F	0.000	0.000	0.000	0.000	0.000	0.000

*** significant at the 1 percent level (α = 0.01), ** significant at the 5 percent level (α = 0.05), *significant at the 10 percent level (α = 0.1). Source: Data Processed by Author (2022)

In this study, two variables ultimately determine the average value of the state property of the exporter and the importer. Therefore, the variable used as an indicator to describe innovation in this study should be the value of the Global Innovation Index (GII) of the exporter and importing countries. Still, when an estimate is made using the two variables mentioned above, the results show that the two variables mentioned do not have a significant effect. This treatment also applies to the variables used to describe the logistics performance in this study, which should be the value of the exporter and importer countries' Logistics Performance Index (LPI). This reason makes this research use the average value of the exporter and importer countries of the two variables, namely the Average Global Innovation Index (AGII) and the Average Logistics Performance Index (ALPI), to obtain maximum results.

Table 3 shows that the model's dependent variable in the form of export diversification is lag. The variable of export diversification as a lag was significant at the 1% level, with a p-value of 0.000. In this case, the lag shows that the model used has a dynamic relationship. The model belongs to the dynamic panel model type because the estimation results in year t are still influenced by year t-1 Čížek (2016). The positive lag variable indicates an increase in the value of export diversification in year t compared to year t-1.

4.1. Validation Test (Hansen Test)

Table 3 shows that all models from model 1 to model 6 are valid because they are overidentifying. The results of the Hansen Test showed significant values at the level of 1 percent, 5 percent, and 10 percent, which means that H0 is supported. In addition, H0 will be accepted when the p-value of the Hansen Test is greater than α, which means that the model used is valid in the estimation using the GMM method.

4.2. Autocorrelation Test (Arellano-Bond Test)

Table 3 shows that all models from model 1 to model 6 do not have autocorrelation problems. The AR(2) value on the Arellano-Bond Test is significant at the 1 percent, 5 percent, and 10 percent levels, which means that H0 is accepted. H0 is accepted when the AR(2) value is greater than α, which means there is no autocorrelation problem in the model used to estimate GMM.

4.3. Robustness Test

Robustness tests conducted using the PLS and FEM methods showed the following results:

Table 4. Estimation Results Using Pooled Ordinary Least Square (PLS)

Variable	*High Tech*		*Med Tech*		*Low Tech*	
	Model 1	**Model 2**	**Model 3**	**Model 4**	**Model 5**	**Model 6**
AGII	0.113	0.099*	0.015**	0.080*	0.018**	0.099*
	0.0004486	0.000463	0.0000491	0.0000114	0.0001002	0.0000805
ALPI	0.062*	0.062*	0.093*	0.077*	0.056*	0.002***
	0.0137646	0.0136937	0.0004252	0.0049971	0.0010917	0.0009984
LFIE	0.021**	-	0.291	-	0.089*	-
	0.0017158		0.0006169		0.0000147	
LFBE	-	0.248	-	0.029**	-	0.069*
		0.0012142		0.0001541		0.0000471
lnGDPDom	0.003***	0.001***	0.777	0.740	0.091*	0.171
	0.0434742	0.047556	0.0004502	0.0009239	0.0000913	0.0108992
lnGDPFor	0.708	0.669	0.700	0.717	0.314	0.291
	0.0002673	0.0003047	0.0000502	0.0004247	0.0003945	0.0004111
lnER	0.020**	0.022**	0.354	0.360	0.182	0.201
	0.000955	0.0009411	0.0006199	0.0000145	0.0000995	0.0000856
Prob > F	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
R-squared	0.9674	0.9711	0.9396	0.9349	0.9163	0.9282
Adj R-Squared	0.9434	0.9471	0.9159	0.9207	0.9090	0.9032

*** significant at the 1 percent level (α = 0.01), ** significant at the 5 percent level (α = 0.05), *significant at the 10 percent level (α = 0.1). Source: Data Processed by Author (2022)

Table 5. Estimation Results Using *Fixed-Effects* (FE)

Variable	*High Tech*		*Med Tech*		*Low Tech*	
	Model 1	**Model 2**	**Model 3**	**Model 4**	**Model 5**	**Model 6**
AGII	0.041**	0.059*	0.067*	0.091*	0.011***	0.035**
	0.0014256	0.0012567	0.0010816	0.00120966	0.0009978	0.0011318
ALPI	0.007***	0.007***	0.091*	0.083*	0.071*	0.077*
	0.437537	0.0450423	0.0068098	0.0076117	0.0045312	0.0054871
LFIE	0.042**	-	0.036**	-	0.014**	-
	0.0057071		0.0022834		0.0020445	
LFBE	-	0.003***	-	0.020**	-	0.098*
		0.002789		0.001006		0.0005853
lnGDPDom	0.017**	0.017**	0.067*	0.088*	0.090*	0.053*
	0.5376199	0.0572321	0.0645238	0.019569	0.0149406	0.0154061
lnGDPFor	0.004***	0.004***	0.185	0.110	0.055*	0.218
	0.0196121	0.02008	0.0152572	0.0188534	0.0075198	0.0049461
lnER	0.006***	0.006***	0.073*	0.065*	0.024**	0.118
	0.017454	0.01781	0.0118113	0.0152601	0.0083387	0.0058515
Prob > F	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
R-squared	0.9094	0.9098	0.9028	0.9023	0.9116	0.9111
rho	0.93846609	0.94205749	0.93311377	0.94348654	0.89976857	0.91901137

*** significant at the 1 percent level (α = 0.01), ** significant at the 5 percent level (α = 0.05), *significant at the 10 percent level (α = 0.1). Source: Data Processed by Author (2022)

One of the criteria for selecting the GMM model is that it is unbiased, where the unbiased estimator is the estimator between the coefficients of Pooled Ordinary Least Squares (PLS) and Fixed-Effects (FE). Therefore, the coefficients of the independent variables generated by PLS will be biased upwards, while those of FE will be biased downwards. Based on the estimation results using the PLS method in Table 3 and the estimation results using the FE method in Table 4, it shows that the GMM model used has met the criteria for selecting the best model and is robust. The GMM model used in this study is the best model because the coefficient values of each method are in accordance with the rules of thumb, namely PLS GMM FE. Based on the estimation results using the PLS and FE methods, which show the coefficient numbers consistent with the estimation results using the GMM method, it can be said that the model used in this study is robust.

Based on the estimation results, it can be seen that innovation has the greatest influence on the diversification of exports of high-tech manufactured industrial commodities compared to the intensity of other technologies. This result is supported by Bayraktutan & BIdIrdI (2018), who states that exporting high-tech commodities requires broader innovation. This is in line with the research of Cirera et al. (2015), Oura et al. (2016), Mallinguh et al. (2020), and Lian et al. (2021), which found that innovation has a positive and significant effect on exports and export diversification. The results of the research by Emodi et al. (2017) show that with innovation, the manufacturing industry will experience development and directly affect export performance. Research by Sandu & Ciocanel (2014), Bottega & Romero (2021), and Ying et al. (2014) also stated that innovation policies have a positive and significant impact on the volume of exports of goods, especially for high-tech commodities. According to the research of Wignaraja (2012), whose estimation results show that innovation will have a very significant positive influence at the industrial level.

Duspara et al. (2017) explain that with innovation, the ability of a country to create new product variations, provide goods and services at a lower cost, and make more complex products increases. Therefore, innovation has a strong correlation with global market success. This statement strengthens the results of the study, which found a positive and significant relationship between innovation and export diversification.

Based on the estimation results, it can be seen that logistics performance has the greatest influence on the diversification of exports of high-tech manufactured industrial commodities compared to the intensity of other technologies. These results are supported by the research of Tang & Abosedra (2019), Puertas et al. (2014), Kabak et al. (2018), Töngür et al. (2020), and Ünal (2020) who also found that logistics performance had a positive and significant influence on export performance. Research by Puertas et al. (2014) proves that the influence of logistics performance has a very strong level of significance on export performance, so logistics performance is an important aspect that must be considered in developing exports. Both the logistics performance of exporting and importing countries have positive coefficients and high numbers. In countries whose logistics performance is considered advanced, the logistics performance of the exporting country has a greater influence on exports than the logistics performance of the importing country. Sénquiz-Díaz (2021) urges developing country governments to focus more on improving policies related to logistics because better logistics performance related to transportation and infrastructure has proven to increase the exports of developing countries.

It can be seen the estimation results show that both the labor force with intermediate education and the labor force with basic education have the greatest influence on the diversification of exports of high-tech manufactured industrial commodities compared to the intensity of other technologies. Even though they both have the greatest influence on the diversification of exports of high-tech industrial commodities, the effect of the labor force with basic education is still smaller than that of the labor force with intermediate education. These results are supported by the research of Stucki (2016), Mubarik et al. (2020), Shahbaz et al. (2019), Gnangnon (2020), and Lian et al. (2021), who also found that education is one of the determinants of exports and export diversification because it has a positive influence. In accordance with the research of Sandu & Ciocanel (2014), knowledge from the workforce will increase exports of high-tech commodities. A more educated and trained workforce will be able to create product specialization that it will lead to an increase in export income (Felipe et al., 2020). In their research, Blanchard & Olney (2017) explain that exports of manufactured industrial commodities will always be associated with a higher average school level compared to exports of agricultural commodities and other sectors. Agosin et al. (2012) asserted that good quality human capital would lead to the specialization of goods to be exported and can make raw goods into manufactured goods that have a higher selling value. Therefore, the higher the intensity of technology used in the production process, the higher the level of education required for human capital. Lian et al. (2021) stated that a workforce with a better level of education and training could help increase diversification and even increase the sophistication of the products produced. This statement aligns with research by Gnangnon (2020) that an educated workforce can increase export concentration, and production will be able to expand so that better education will increase export diversification. This statement is evidenced by the estimation results using the GMM method by Gnangnon (2020) found that education has a positive and significant effect at the level of 1 percent on export diversification calculated using the HHI method.

Based on the estimation results, it can be seen that the GDP of the exporting country has the greatest influence on the diversification of exports of high-tech manufactured industrial commodities compared to the intensity of other technologies. This result is supported by research that finds that GDP has a positive and significant effect on export performance and export (Espoir, 2020; Agosin et al., 2012; Xing, 2018; Sekkat, 2016). Research conducted by Espoir (2020) found that GDP contributed positively and significantly to the export diversification process, and export diversification had a positive and significant impact on GDP growth. The results of this study are also supported by the research of Agosin et al. (2012), which states that the GDP growth of an exporter country will be able to assist in the process of developing new sectors in export commodities so that export diversification can be achieved. Furthermore, in accordance with the research of Cimoli et al. (2012), the GDP of the exporting country has a positive and significant effect because a higher GDP will trigger an increase in technology in production and will later have an influence on the production process in the manufacturing industry.

Based on the estimation results, it can be seen that the GDP of export destination countries affects only on the export diversification of low-tech manufacturing industrial commodities. Blanchard & Olney (2017) show that the importing country's GDP contributes to export performance because it positively influences the number of exports. Appleyard & Field (2014) explain that the importing country's GDP positively influences the export volume of the exporting country. This is because high consumer income will cause the volume or value of goods purchased from an exporter country to increase. This statement is in line with Xing (2018), which states that the results showing a positive and significant effect of the importing country's GDP on exports are in accordance with the gravity model, which explains that countries with high incomes will have higher purchasing power so that demand for imports will increase.

Based on the estimation results, it can be seen that the exchange rate has the greatest influence on the diversification of exports of high-tech manufacturing industrial commodities compared to the intensity of other technologies. Research on the effect of the exchange rate on exports is still debate because it shows different results. Research on the effect of the exchange rate on exports is still debated because it shows different results. The results of this study align with the research of Sekkat (2016) and Cimoli et al. (2012), which shows that the exchange rate has a positive and significant effect on export diversification. The positive effect caused by the appreciation of the currency will help increase the number of exports because the domestic price of the exporting country will be considered cheaper by the importing country. Research conducted by Vindayani et al. (2015) also stated that an appreciating currency would lead to an undervalued currency, which causes domestic prices to become cheaper and causes production to increase. This is in line with the research by Imoughele & Ismaila (2015), which found that exchange rate depreciation had a negative effect on exports in Nigeria. Although this study and several other studies have proven that the exchange rate has a positive and significant effect on export diversification, some studies find that the exchange rate does not have a significant effect, as shown in model 5 in this study. Research by Agosin et al. (2012) proved that the change in the exchange rate was not an important factor in influencing export diversification because, based on the GMM test, the exchange rate showed insignificant results. According to Sugiharti, Esquivias, & Setyorani (2020), the exchange rate has a different effect on exports in each commodity and export destination country.

5. CONCLUSION

This study aimed to analyze the impact of innovation, logistics performance, and human capital on the effect of exports diversification in Indonesia using the Generalized Method of Moments (GMM). Based on the discussion described in the previous chapter, it can be concluded that innovation positively and significantly impacts the diversification of manufacturing industry commodity exports in all technological intensities because innovation can increase productivity. Logistics performance has a positive and significant impact on the diversification of manufacturing industry commodity exports in all technological intensities because the better the logistics performance, the easier the export process will be. Human capital associated with the education dimension has a positive and significant impact on the diversification of manufacturing industry commodity exports in all technological intensities because the higher the workforce's education, the greater their ability to master technology, leading to increased productivity.

The GDP of the exporting country has a positive and significant effect on the diversification of exports of manufactured industrial commodities in all technological intensities. The higher the GDP of the exporting country, the diversification of exports can be better facilitated. The GDP of the importing country has a positive and significant effect on the diversification of exports of manufactured industrial commodities, but only at low technology intensity because the higher the GDP of the importing country, the greater the purchasing power will increase its exports, but the higher the GDP of the importing country, the higher the mastery of technology in high-tech manufacturing industry and will produce itself and won’t export. The exchange rate has a positive and significant effect on the diversification of exports of manufactured industrial commodities across technological intensities. This is because the more the exchange rate is appreciated, the lower the price of export goods will be for the importing country so the importing country will prefer to import compared to doing its own production.

This study was written in accordance with existing manuals and has limitations, such as the export diversification proxy used in this study requires additional robustness tests to validate that export diversification captures the expected effect. The use of the Global Innovation Index (GII) variable as an indicator that represents innovation in each country is still very limited because most studies use R&D and patent variables to represent innovation. The availability of Logistics Performance Index (LPI) data causes researchers to be unable to estimate the variables optimally. The human capital variable in this study only uses the educational aspect. In this study, the importing country's GDP variable showed insignificant results in most models so it could be replaced or added with other variables.

Based on the conclusion that innovation has a positive and significant impact on export diversification, it is recommended that Indonesia pay more attention to indicators of innovation, such as encouraging innovation through more R&D expenditure, improving the quality of products through the patent right, giving more incentives or subsidies to the firm that has division of technological research. Hence, the export diversification can be achieved. Based on the conclusion that logistics performance has a positive and significant impact on export diversification, it is recommended that Indonesia build a better transportation infrastructure to facilitate export activities more optimally so that export diversification can be achieved. Furthermore, based on the conclusion that labor education has a positive and significant effect on export diversification, it is recommended that Indonesia improve the quality of education, especially higher education, and conduct more manpower training so that the availability of highly educated workers can increase and achieve export diversification.

In addition, there are suggestions for further research. Future research is expected to be able to examine using data at the company level covering more countries and commodities to better describe the variables of export diversification. Future research is expected to consider robustness tests using other export diversification calculation methods, such as the Gini Index and Theil Index, to ensure that changes in the export diversification index are not the result of a decline in export performance. Future research is expected to add appropriate variable proxies to describe innovations such as R&D and patents. Further research is expected to be able to expand the human capital variable by using variables from other aspects, such as health and workforce training. Future research is expected to find the right control variables and shows significant results in examining export diversification factors such as economic distance, population, and others. Future research is expected to be able to find the right proxy method to estimate the problem of export diversification better.

REFERENCES

Agosin, M. R., Alvarez, R., & Bravo-Ortega, C., 2012. Determinants of export diversification around the world: 1962–2000. *The World Economy,* 35(3), 295-315.

Andersson, M., & Johansson, S., 2010. Human capital and the structure of regional export flows. *Technology in Society,* 32(3), 230-240.

Aneja, R., & Arjun, G., 2021. Estimating components of productivity growth of Indian high and medium-high technology industries: A non-parametric approach. *Social Sciences & Humanities Open,* 4(1), 100180.

Auray, S., Fuller, D. L., & Vandenbroucke, G., 2021. Comparative advantage and moonlighting. *European Economic Review,* 139, 103897.

Azar, G., & Ciabuschi, F., 2017. Organizational innovation, technological innovation, and export performance: The effects of innovation radicalness and extensiveness. *International business review,* 26(2), 324-336.

Baltagi, B. H., 2008. *Econometric Analysis of Panel Data (Vol. 4).* Chichester: John Wiley & Sons.

Bayraktutan, Y., & Bıdırdı, H., 2018. Innovation and high-tech exports in developed and developing countries. *Journal of International Commerce, Economics and Policy,* 9(03), 1850011.

Bierut, B. K., & Kuziemska-Pawlak, K., 2017. Competitiveness and export performance of CEE countries. *Eastern European Economics,* 55(6), 522-542.

Blanchard, E. J., & Olney, W. W., 2017. Globalization and human capital investment: Export composition drives educational attainment. *Journal of International Economics,* 106, 165-183.

Bottega, A., & Romero, J. P., 2021. Innovation, export performance and trade elasticities across different sectors. *Structural Change and Economic Dynamics,* 58, pp.174-184.

Brenton, P., & Hoppe, M., 2007. *Clothing and Export Diversification: Still Aroute to Growth for Low-income Countries?* (Vol. 4343). World Bank Publications.

Breschi, S., & Helg, R., 1996. *Technological Change and International Competitiveness: The Case of Switzerland*. LIUC Universita Carlo Cattaneo.

Budnikevych, I., & Honchar, V., 2020. Regulatory mechanisms of ukrainian pharmaceutical market competitiveness in the context of european integration. *Three Seas Economic Journal,* 1(3), 1-8.

Buisán, A., Learmonth, D., & Sebastiá-Barriel, M., 2005. *An Industry Approach to Understanding Export Performance: Stylised Facts and Empirical Estimation* (No. 0503). Banco de España & Occasional Papers Homepage.

Burlutskyi, S., Burlutska, S., & Berezianko, T., 2019. The Export Determinant of Socio-Economic Resilience in Foreign Economic Activity. *Journal of Life Economics,* 6(4), 413-420.

Cimoli, M., Fleitas, S. and Porcile, G., 2011. *Real Exchange Rate and the Structure of Exports* (No. 37846). University Library of Munich, Germany.

Cirera, X., Marin, A., & Markwald, R., 2015. Explaining export diversification through firm innovation decisions: The case of Brazil. *Research Policy,* 44(10), 1962-1973.

Čížek, P., 2016. Generalized method of trimmed moments. *Journal of Statistical Planning and Inference,* 171, 63-78.

Darmanto, E. B., Handoyo, R. D., & Wibowo, W., 2021. The impact of Asean-China Free Trade Area (ACFTA) agreement on Indonesia's major plantation export commodities. *Business: Theory and Practice,* 22(1), 91-97.

Donaldson, D., 2018. Railroads of the Raj: Estimating the impact of transportation infrastructure. *American Economic Review,* 108(4-5), 899-934.

Duspara, L., Knežević, S., & Turuk, M., 2017. Competitiveness and innovation challenge in Croatia. *Poslovna izvrsnost,* 11(2), 41-57.

Emodi, N. V., Murthy, G. P., Emodi, C. C., & Emodi, A. S. A., 2017. Factors influencing innovation and industrial performance in Chinese manufacturing industry. *International Journal of Innovation and Technology Management,* 14(06), 1750040.

Engel, J., Kokas, D., Lopez-Acevedo, G., & Maliszewska, M., 2021. *The Distributional Impacts of Trade: Empirical Innovations, Analytical Tools, and Policy Responses.* World Bank Publications.

Espoir, L. M., 2020. Determinant of export diversification: An empirical analysis in the case of SADC countries. *International Journal of Research in Business and Social Science*, 9(7), 130-144.

Fernandes, A. M., Ferro, E., & Wilson, J. S., 2019. Product standards and firms' export decisions. *The World Bank Economic Review,* 33(2), 353-374.

Fernandes, A. M., Mattoo, A., Nguyen, H., & Schiffbauer, M., 2019. The internet and Chinese exports in the pre-ali baba era. *Journal of Development Economics,* 138, 57-76.

Fontes, L. F., Granitoff, I., & Tai, S. H. T., 2020. Export wage premium for south Brazilian firms: Interaction between export, human capital, and export destination. *EconomiA,* 21(3), 365-376.

Gnangnon, S. K., 2021. Manufacturing exports and services export diversification. *The International Trade Journal,* 35(3), 221-242.

Hsu, J., & Chuang, Y. P., 2014. International technology spillovers and innovation: Evidence from Taiwanese high-tech firms*. The Journal of International Trade & Economic Development,* 23(3), 387-401.

Huang, X., Song, X., & Hu, X., 2018. Does "Internet Plus" promote new export space for firms? Evidence from China. *China & World Economy,* 26(6), 50-71.

Kabak, Ö., Ülengin, F., & Ekici, Ş. Ö., 2018. Connecting logistiks performance to export: A scenario-based approach. *Research in Transportation Economics,* 70, 69-82.

Karlsson, C., & Gråsjö, U., 2013. Accessibility: A useful analytical and empirical tool in spatial economics–experiences from Sweden. *CESIS: Electronic Working Paper Series,* 314.

Kirbach, M., & Schmiedeberg, C., 2008. Innovation and export performance: adjustment and remaining differences in East and West German manufacturing. *Economics of Innovation and New Technology,* 17(5), 435-457.

Kovačević, R., 2019. The export performance of the euro area: A panel quantile regression approach. *Economic Annals*, *64*(222), 7-61.

Lian, W., Liu, F., Svirydzenka, K., & Zhu, B., 2021. A diversification strategy for South Asia. *IMF Working Papers,* 2021(202).

Mahajan, V., 2020. Is productivity of Indian pharmaceutical industry affected with the introduction of product patent act?. *Indian Growth and Development Review,* 13(1), pp.227-258.

Mallinguh, E., Wasike, C., & Zoltan, Z., 2020. Technology acquisition and smes performance, the role of innovation, export and the perception of owner-managers. *Journal of Risk and Financial Management,* 13(11), 258.

Mankiw, N. G., 2006. The macroeconomist as scientist and engineer. *Journal of Economic Perspectives,* 20(4), 29-46.

Márquez-Ramos, L., & Martínez-Zarzoso, I., 2010. The effect of technological innovation on international trade. *Economics,* 4(1).

Madzova, V., 2018. The impact of competitiveness on export performance of the Republic of Macedonia. *InTraders International Trade Academic Journal,* 1(1), pp.23-45.

Mazzi, C. T., & Foster-McGregor, N., 2021. Imported intermediates, technological capabilities and exports: *Evidence from Brazilian firm-level data. Research Policy,* 50(1), 104141.

Monreal-Pérez, J., Aragón-Sánchez, A., & Sánchez-Marín, G., 2012. A longitudinal study of the relationship between export activity and innovation in the Spanish firm: The moderating role of productivity. *International Business Review,* 21(5), 862-877.

Mubarik, M.S., Devadason, E.S. and Govindaraju, C., 2020. Human capital and export performance of small and medium enterprises in Pakistan. *International Journal of Social Economics,* 47(5), pp.643-662.

Oura, M. M., Zilber, S. N., & Lopes, E. L., 2016. Innovation capacity, international experience and export performance of SMEs in Brazil. *International Business Review,* 25(4), 921-932.

Pla-Barber, J., & Alegre, J., 2007. Analysing the link between export intensity, innovation and firm size in a science-based industry. *International Business Review,* 16(3), 275-293.

Puertas, R., Martí, L., & García, L., 2014. Logistics performance and export competitiveness: European experience. *Empirica,* 41(3), 467-480.

Romer, P. M., 1990. Endogenous technological change. *Journal of political Economy,* 98(5, Part 2), S71-S102.

Salvatore, D., 2012. *Introduction to International Economics.* Hoboken, NJ: Wiley.

Samen, S., 2010. A primer on export diversification: key concepts, theoretical underpinnings and empirical evidence. *Growth and Crisis Unit World Bank Institute*, 1-23.

Sandu, S., & Ciocanel, B., 2014. Impact of R&D and innovation on high-tech export. *Procedia Economics and Finance,* 15, 80-90.

Sekkat, K., 2016. Exchange rate misalignment and export diversification in developing countries. *The Quarterly Review of Economics and Finance,* 59, 1-14.

Sénquiz-Díaz, C., 2021. Transport infrastructure quality and logistics performance in exports. *Economics,* 9(1), 107-124.

Shahbaz, M., Gozgor, G., & Hammoudeh, S., 2019. Human capital and export diversification as new determinants of energy demand in the United States. *Energy Economics,* 78, 335-349.

Stucki, T., 2016. How the founders' general and specific human capital drives export activities of start-ups. *Research Policy,* 45(5), 1014-1030

Sugiharti, L., Esquivias, M. A., & Setyorani, B., 2020. The impact of exchange rate volatility on Indonesia's top exports to the five main export markets. *Heliyon,* 6(1), e03141.

Sugiharti, L., Purwono, R., & Padilla, M. A. E., 2020. Analysis of determinants of Indonesian agricultural exports. *Entrepreneurship and Sustainability Issues*, *7*(4), 2676.

Tang, C. F., & Abosedra, S., 2019. Logistiks performance, exports, and growth: Evidence from Asian economies. *Research in Transportation Economics,* 78, 100743.

Todaro, M. P., & Smith, S. C., 2014. *Human Capital: Education and Health in Economic Development-in Economic Development*. 12th Edition. The Pearson Series in Economics.

Töngür, Ü., Türkcan, K., & Ekmen-Özçelik, S., 2020. Logistics performance and export variety: Evidence from Turkey. *Central Bank Review,* 20(3), 143-154.

Tran, T. A. D., Phi, M. H., & Diaw, D., 2017. Export diversification and real exchange rate in emerging Latin America and Asia: A South–North vs. South-South decomposition. *The Journal of International Trade & Economic Development,* 26(6), 649-676.

Ullah, S., Akhtar, P., & Zaefarian, G., 2018. Dealing with endogeneity bias: The generalized method of moments (GMM) for panel data. *Industrial Marketing Management,* 71, 69-78.

Vindayani, D., Hakim, D. B., & Asmara, A., 2015. Pengaruh misalignment nilai tukar terhadap kebijakan safeguards di Asean-5. *Buletin Ekonomi Moneter dan Perbankan,* 18(1), 61-84.

Wignaraja, G., 2012. Innovation, learning, and exporting in China: Does R&D or a technology index matter?. *Journal of Asian Economics,* 23(3), 224-233.

Ying, S., Miao, L. and Yibo, C., 2014. High-tech products export competitiveness, bric countries in US market: a comparative analysis. *The Journal of Developing Areas,* pp.195-218.